Towards A National "State of Water Resources" Report

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Abstract

Both internationally and nationally it has become imperative to report on the implementation of various water management goals. The key determinant across virtually all regions and scales of analysis is the relationship between the availability of freshwater and the requirement for its use. In this paper a planned "State of Water Resources of South Africa" report is discussed and the challenge to produce it routinely based on a national monitoring data sets and make it meaningful to a variety of stakeholders.

Keywords: *water resources management, targets, and national reporting, state of resources.*

1 Introduction

National and international reporting on sustainable use and management of scarce natural resources in relation to agreed management goals has also become a key part of water resources management in South Africa. Regular reporting to the Commission for Sustainable Development, outflow of the 1992 World Summit for Sustainable Development, has already been undertaken for a number of years. A first comprehensive national report "Managing Water Wisely in South Africa" to the UN World Water Assessment Programme is close to completion. The challenge now is to produce the various report components regularly and routinely as part of the normal water resources management functions. The Water Resources Information Management component of the DWAF has set itself the objective to produce the first State of Water Resources Report by April 2006. This will require a greater focus on resources assessment, on various users of information and on cooperation across the scientific disciplines of the large number of DWAFs hydrological, water quality and aquatic ecosystem health monitoring programmes.

This paper discusses the growing need of reporting, the intended scope of a South African state of water resources report and some of challenges and possible approaches to address them.

2 International Water Resources Sustainability Concerns

National reporting has become a major issue since the recognition of the unsustainable use of our scarce natural resources, including water, air, soil and vegetation and the further recognition that a sustainable development would not be possible without the understanding and full involvement of all sectors of society. While conservation had previously been the domain of nature conservation agencies and environmentalists, the UN Conference on Environment and Development in 1992 in Rio de Janeiro was a milestone in that the world's political leaders had started to drive the environmental agenda. The gathering produced Agenda 21, a programme of action for the protection of the world's environmental resources, including water. The well-known Chapter 18 sets out the protection of the quality and supply of freshwater resources in seven programme areas for action through the application of integrated approaches to the development, management and use of water resources.

Since then international target-setting with regard to sustainable development has rapidly increased as international concerns about unsustainable behaviour and its impacts, in particular climate change, have risen. This culminated in the UN Summit of 2000, which set the Millennium Development Goals for 2015, the most influential targets to date.

The international water sector pursued its own concerns at a number of World Water Forums. At the 2nd one in The Hague, the Ministerial Declaration adopted seven challenges as the basis for future action:

1. Meeting basic needs – for safe and sufficient water and sanitation
2. Securing the food supply – especially for the poor and vulnerable through the more effective use of water
3. Protecting ecosystems – ensuring their integrity via sustainable water resource management
4. Sharing water resources – promoting peaceful cooperation between different uses of water and between concerned states, through approaches such as sustainable river basin management
5. Managing risks – to provide security from a range of water related hazards
6. Valuing water – to manage water in the light of its different values (economic, social, environmental, cultural) and to move towards pricing water to recover the costs of service provision, taking account of equity and the needs of the poor and vulnerable
7. Governing water wisely – involving the public and the interests of all stakeholders.

A further four challenges were added to the above seven to widen the scope of the analysis:

8. Water and industry – promoting cleaner industry with respect to water quality and the needs of other users
9. Water and energy – assessing water's key role in energy production to meet rising energy demands
10. Ensuring the knowledge base- so that water knowledge becomes more universally available
11. Water and cities-recognizing the distinctive challenges of an increasingly urbanized world.

While water had been one of many concerns at Rio in 1992, it rose to the top of the international sustainability agenda at the 2nd World Summit for Sustainable Development, this time in Johannesburg. The basis for this was the climatic situation and massive development backlogs in Africa and the crucial role that water would play in a sustainable development of the continent. Groundwork had also been done at The Hague where African leaders had developed an African Water Vision:

> "An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment."
>
> *AfDB et al (2000)*

The framework for action in achieving the African Water Vision calls for:

- Strengthening institutional governance of water resources;
- Improving water wisdom;
- Meeting urgent water needs; and
- Strengthening financial base for desired water future.

The vision for 2025 is underpinned by a comprehensive set of milestones and targets within the above-mentioned framework for action.

3 National Reporting on Water Resources

The international reporting imperative is directly related to the various action agendas. At the highest political level are the annual reports to the Commission for Sustainable Development. The year 2000 saw the launch of the World Water Assessment Programme (WWAP), a UN System-wide effort. (WWAP – www.unesco.org/water/wwap).
Out of this initiative came the 1st World Water Development Report in 2003. While this report was a top-down effort coordinated by the UNESCO – International Hydrological Programme, the second report, to be ready for the 4th World Water Forum in Mexico City in 2006, is to be based on country inputs as far as possible.

The WWAP is therefore supporting and encouraging countries in strengthening their monitoring and information management systems for the monitoring, assessment and reporting of progress in their national water situation. The South African Department of Water Affairs and Forestry took up this initiative after having had to deal with an increasing number of national and international reports every year on virtually an ad hoc basis.
The decision was to adapt the WWAP reporting outline to a comprehensive water sector-reporting framework for South Africa (DWAF, 2005) and in parallel develop a national reporting system, which could meet all the main water reporting requirements. Such a system will include:

- Regularly updated inventory of required reports;
- An agreed framework for each report;
- Identified line functionaries who are responsible for policy, key performance areas, objectives and indicators in their functional area and for ensuring that appropriate monitoring is taking place, which measures the performance of their functional area against the set indicator;
- A depository of standardised inputs which can be shared by various reports;
- This system can be set up now and be developed, over time, into a comprehensive electronic information system.

4 Continuous assessment of water resources

Agenda 21 recognized that the widespread scarcity, gradual destruction and aggravated pollution of freshwater resources in many world regions, along with the progressive encroachment of incompatible activities, demand integrated water resources planning and management. Agenda 21 also recognized that water resources assessment constitutes the practical basis for the sustainable management of water resources and a prerequisite for evaluation of the possibilities for their development. It defined this required water resources assessment as the continuing determination of sources, extent, dependability and quality of water resources and of the human activities that affect those resources (UNEP, 1992). The challenge of appropriate information to underpin Integrated Water Resources Management was taken up in the South African Policy White Paper of 1997 and the National Water Act, 1998. The following should be undertaken as part of an overall programme of resources monitoring (DWAF, 1997):

- Assessment of the status of water resources, and communication of information, in order to support decisions on management, development and allocation of water resources;
- Ongoing monitoring, and investigations, where appropriate, of:
    - resource use (both water use and discharge quality) in different sectors;
    - the status of water resources (surface and groundwater), in terms of water quantity, resource quality and demands on the resources;
    - impacts on water resources, including the impacts of waste discharges, land uses, water abstraction and climatic conditions;
- Auditing of:
    - sectoral resource use patterns and assessment of whether objectives are being reached;
    - compliance with registration and permit conditions;
    - achievement of objectives for resource protection and management.

This requirement has been fully taken up in Chapter 14 of the National Water Act, 1998, entitled “Monitoring, Assessment and Information.” In response to this requirement, DWAFs Scientific Services component became the Water Resources Information Management component as part of DWAFs major restructuring in 2003. The role of this restructured component is to develop and maintain the systems and programmes for data and information acquisition, assessment and management, and to coordinate, support and audit their implementation by DWAF and WMIs. To work towards a more integrated and coordinated approach to water resources monitoring, a Strategic Framework (DWAF, 2004a) and a 5 Year Resource Quality Monitoring Plan have been developed (DWAF, 2004b).

The Framework and Plan provide a significant opportunity for sharing resources, infrastructure and data or information produced at a particular level across the other levels. The National reporting will focus mainly on the National level, whereas it can be expected that CMAs will very soon start reporting at the Regional/WMA/ catchment level, probably with a significant sharing of information between the two levels.

5 Indicators as a means of measuring progress

The appropriate way to measure and report progress towards various aspects of sustainable development is by means of agreed indicators. These indicators should describe a summary of conditions, rather like temperature and blood pressure are used to describe human health. They have been used for many years by economists to explain economic trends, a typical example being Gross National Product, but have only fairly recently been used to determine the sustainability of environmental systems as required by Agenda 21 (Walmsley (J), 2002).

In the World Water Development Report issued by the WWAP in 2003, a total of 176 indicators are proposed for covering eleven different challenge areas. In analyzing the relevance of the WWAP indicator issues for South Africa, Walmsley (D) et al (2004) found a high degree of linkage between the Key Focus Areas of the South African National Water Resources Strategy with the WWAP issues. That does not mean that internationally proposed indicators can just be taken over into country reporting. The process of developing and evaluating indictors can be complex and time consuming, involving both technical and stakeholder evaluation to reflect the unique physical and socio-economic environment of a country. There are already numerous indicator initiatives that have taken place in South Africa, all of which have developed and described indicator sets for use at national, provincial, catchment and local levels. Although most of these have focused on indicators for general state of environment reporting, they have included water sector indicators, and more importantly those that are relevant to the achievement of the Millennium Development Goals (Walmsley (D) et al, 2004).

6 Framework for State of Water Resources Reporting

In the past, many different water resources status reports have been produced on a once-off basis and to meet a particular need. Now that the international and national developments outlined in the previous sections require a more systematic and comprehensive reporting, a framework has become necessary. Such a framework is required to outline the desired scope and content and achieve of a coherent picture from various specialist contributions as well as continuity between one reporting period and the next one. Furthermore a framework can provide direction to the data acquisition, data management and information product preparation.

None of this has been achieved to date, and the intention with the paper was to promote rapid advance of a function cross-cutting approach within DWAF to achieve a prototype report by April 2006 and secondly to open the team's thinking to date to external criticism. In Table 1 various water resources components and suggested indicators to report status are shown. Rather than being comprehensive, it reflects our present understanding of the scope and our ability in different functional areas to produce suitable information products form the data available to us. The table also provides some comments on the data sources. Furthermore some examples of proposed indicators and their representation are shown in Figures 1-8. Time did not allow for a coherent data set and a common presentation standard. The purpose is to help with the thinking on content and presentation for the first report itself.

Table 1: Proposed scope for a National State of Water Resources Report

COMPONENT	INDICATORS	COMMENT
Climate	1. Monthly temperature as % of mean	South Africa Weather Services (SAWS)
Rainfall	1.Monthly rainfall per Province 2.Monthly distribution at key rainfall stations 3. Standard precipitation index	SAWS SAWS/DWAF WRC project
Surface water	1.State of reservoirs (% of Full Supply Capacity) 2.Flow time series for selected stations 3. Impact of use (actual flows as % of natural flow at sites) 4. Selected flow duration curves 5. Floods and Droughts (Extreme event statistics at affected sites)	DWAF DWAF DWAF/WR 90 For comparison with other indicators, e.g. quality and river health, reserve, specified minimum flows, international agreements DWAF
Groundwater	1.Change in groundwater storage (compared to previous year) 2.Groundwater development as an investment (Drilling and infrastructure development compared to building of dams) 3.Total groundwater abstraction 4.Groundwater abstraction as % of recharge 5. Groundwater level map (depth to groundwater) 6.Linkage: groundwater levels and surface water conditions at selected sites	70 groundwater level time series available (Not adequate for national picture) Groundwater industry Regular broad-scale survey DWAF DWAF DWAF
Water quality	1.Water quality status (e.g. TDS, suspended solids, phosphorus) in relation to water use guidelines 2.Water quality status of reservoirs (as above, including total suspended solids)	DWAF DWAF

	3. Eutrophication status of reservoirs 4. Faecal pollution status 5. Ecosystem Health (Ecostatus combining water quantity, and quality and geomorphology information)	DWAF Limited DWAF network River Health Programme (Link to flow and chemistry as drivers)
Water use	1.Maps (as cover and change in cover) of sectoral water use, e.g. urban areas, afforestation, various agricultural uses, farm dams, vegetation cover (natural and alien) 2.Recent catchment water balances from other studies 3. Registered water use per Water Management Area 4.Water quality fractions as indicator of impact	Human impacts cannot be portrayed to the detail of a water balance here, but only as background to the water resource status information. National Water Resources Strategy WARMS information system DWAF

7 Feasibility of regular status reporting

The feasibility with regard systematic status reporting is discussed here with reference to the future requirements, the analysis challenges, the situation and vision in DWAF and some thoughts for a way forward.

7.1 Future requirements

The main purpose of producing comprehensive and regular information on the state of water resources is that it should influence water resources decision-making. To be able to do this in a coherent way requires attention to the relationships between the water resources status, the impacts it has received through various human pressures and the management responses to change the pressures or a ameliorate the inputs. A systematic way to do this is through the Driving Forces-Pressure-Impact-Reponse (DPSIR) sustainability framework developed by the European Environment Agency. The DPSIR framework provides a system-analysis view of the relations between the environmental system and the human system. According to this way, social and economic developments (driving forces) exert pressure on the environment and as a consequence, the state of the environment changes, e.g. resource availability and biodiversity. This leads to impacts on the human value and ecological integrity of the resource that may elicit a societal response that feeds back to all the other elements (Walmsley (J), 2002).

With its past focus in South Africa on supply management and the creation of water resources infrastructure, there had been limited incentive for comprehensive water resources assessment. The increased focus on demand management and the optimization of resource conservation and use for a variety of societal needs will require a much stronger science-led water resources management. It can be expected that this new phase will take a major leap foreword when we start to set management classes for our water resources and underpin this with specific Resource Quality Objectives in terms of the National Water Act, 1998. The backsword ripple effect that the European Framework Directive had, with its requirement of a class of good by 2015 for all water bodies in Europe is a good illustration of the expected impact, i.e. immediate reviews of the impacts of human activity, a resultant focusing of monitoring programmes, regular resource assessments and all this leading to the river basin management plans through which the resource class is to be achieved.

7.2 Analysis challenges

Integrated water resources assessment will become crucial if we want to support Integrated Water Resources Management. This should include the interface between surface and groundwater, the various water quantity / quality relationships and the impact of catchment land-based activities on water resources. A framework for integrated resource assessment and needs to build on a very new field of hydrology, namely ecohydrology. In general, catchment processes like rainfall, evaporation, infiltration, groundwater recharge, runoff, erosion, pollutant transport and decomposition are integrated processes which need to be assessed in integrated ways if we want to optimize the beneficial use of the resource.

This presents an immediate challenge to national reporting, because existing data collection, data management and resource assessment programmes are not geared to a routine comprehensive assessment. The broad-based water resources baseline studies, Water Resources of South Africa, now undertaken for the fourth time in 40 years as WR 2005, is a major undertaking, requiring the capacity of the key consulting firms in this field in South Africa. And this effort to date had been mainly on surface water, whereas WR 2005 will also for the first time include groundwater and water quality assessments.

To be able to seriously address integrated assessment we will have to work right back to our monitoring programmes. An example in this regard is the Mid Atlantic Integrated Assessment (MAIA) programme in the United States, where an integrated monitoring and assessment approach has been developed in the nineties which was to be representative of what is happening in an area, including forestry, fish, wildlife, water quantity and quality. In this way it was possible to develop a considerable number of relationships regarding sustainability, effectiveness of regulations etc. (Howman and Nepfumbada, 2000)

An initial challenge in national reporting will therefore be to present maps and graphs of pressure and status information in such a way that questions will start to be asked about specific relationships that will, over time, lead to more precise analysis.

7.3 Situation and vision within DWAF

In line with its new responsibility of policy, regulation and support, DWAF is striving towards an effective and efficient national information service (Braune et al, 2004). A major gap towards this goal is an appropriate water resources assessment programme and the capacity in this regard. This can be put into an international context by looking at the balance in functions that US Geological Survey, a well-established national hydrological survey, tries to achieve. Overall the Water Resources Division of the USGS works on a mix of (1) long-term data collection, (2) interpretation and assessment and (3) research and development. Each of the three components has its own base of customers and constituencies, but the real strength of the service comes from the combination of al three components and the linkage among them (USGS, 1999). The strong assessment focus becomes clear if one just takes the objectives of one of the USGS monitoring programmes, namely, the National Water Quality Assessment programme (NAWQA):

Status:	Describe the quality of the Nation's water resources in a nationally consistent manner;
Trends:	Assess long-term trends and changes in water quality;
Understanding:	Identify, describe and explain factors that govern water quality

(Howman and Nepfumbada, 2000)

However, such an approach is very resource intensive, but is worth mentioning for greater context. The NAWQA programme has divided the country into study units, and has a multi-disciplinary team of 4 different specialists, a database manager, a number of post-graduate students and technical support for each of these units. From the above it should be clear that DWAF will need a much stronger focus on resource assessment in future to get the full benefit of its national monitoring programmes. Examples, where this is starting to happen is in the River Health Programme and in the Groundwater Resource Assessment phase II and III. Furthermore, with restructuring in 2003 a unit "Integrated Water Resources Studies" has been created which is to build at least a core capacity for water resources assessment within DWAF. The regular status of water resources reporting was taken up as the first challenge.

The objectives of the River Health Programme can serve as example in South Africa:

- Measure, assess and report on the ecological state of aquatic ecosystems;
- Detect and report on spatial and temporal trends in the ecological state of aquatic ecosystems;
- Identify and report on emerging problems regarding aquatic ecosystems;
- Ensure that all reports provide scientifically relevant information for national aquatic ecosystem management (WRC, 2001).

7.4 Elements of a way forward

Moving from ad hoc studies to systematic and comprehensive reporting on the state of water resources will require a strategic approach. The programmatic approach, cutting across different functions that is being implemented in the Water Resources Information Management component of DWAF has created a platform from which integrated water resources assessment can take place. Greater pooling of DWAFs limited water resources assessment capacity will become essential. The Integrated Water Resources Planning component has progressed considerably to develop the tools through which even complex analyses could be achieved in a routine way. Their Water Situation Assessment Model (WSAM) was conceived as a reconnaissance level planning tool, but appears to be also highly suited for state of water resources reporting. It is set up to analyse the relationship between water requirements and supply in a catchment and is supported by a database of pre-processed hydrological records as well as the land use and water use situations for all quaternary catchments. It still lacks adequate routines to systematically incorporate water quality assessment, but that could be overcome in a cooperative effort.

As part of the greater outward focus, the DWAF Water Resources Information Management component is working towards an aligned website for its different functional units, comprising hydrology, geohydrology water quality, water resource quality and spatial and land management information. It is foreseen that the "State of Water Resources" will become a dynamic report of which the component parts will be available on the web, and updated as new information becomes available.

Lastly, it can be expected that national reporting will rapidly progress as user demand increases. In this regard an important step has already been taken with the imminent establishment of an Advisory Committee for Water Resources Modelling. A follow-on step already envisaged within the next 3 years is the establishment of a National Advisory Committee on Water Information.

8 Conclusion

Sustainable use and management of scarce water resources for national development objectives will be impossible without regular reporting on the state of water resources. To be meaningful to a variety of stakeholders and encourage decision-making, such reports should provide an integrated assessment of the various resource components, the pressures on them and the resulting impacts. This goes well beyond the present focus on resource data collection and ad hoc assessments for a variety of purposes. To approach a regular and systematic assessment of the state of water resources will require a strategic approach to integrated data acquisition, assessment methodologies and tools and information systems. If this is pursued vigorously it should have a beneficial effect on appropriate water resources assessment at other scales too.

9 Acknowledgement

The permission of the Director-General of the Department of Water Affairs and Forestry to present this paper is gratefully acknowledged. Contributions to the scope and content of a first state of water resources report as outlined here are all from a crosscutting team from all four directorates of the DWAF Water Resources Information Management component. Their inputs and spirit of cooperation are highly appreciated.

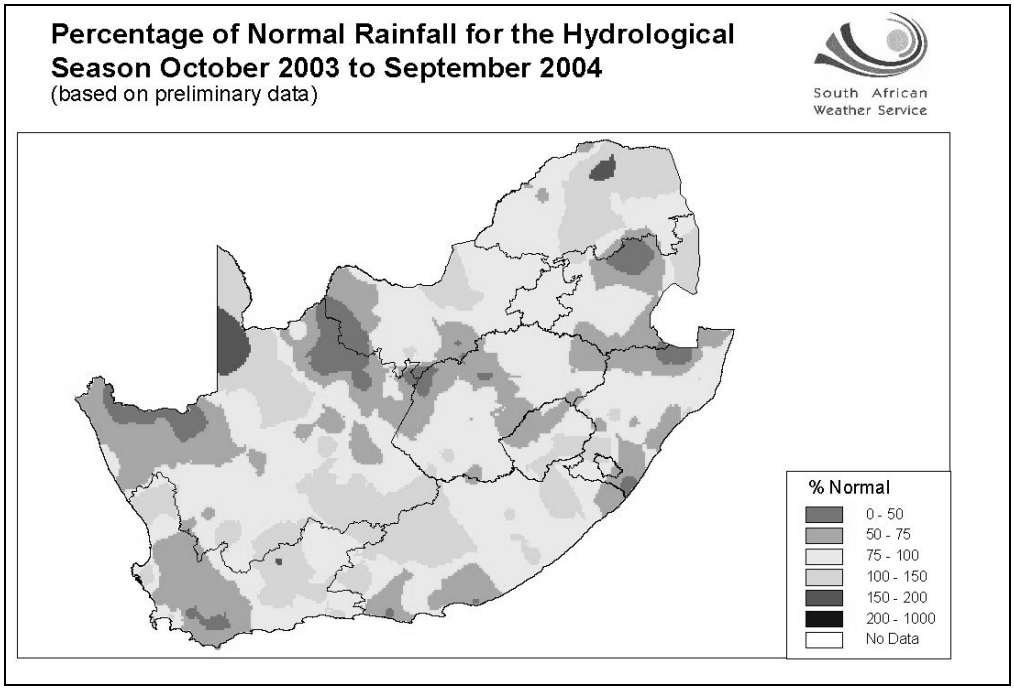

Figure 1: Example: Rainfall as percentage of annual rainfall

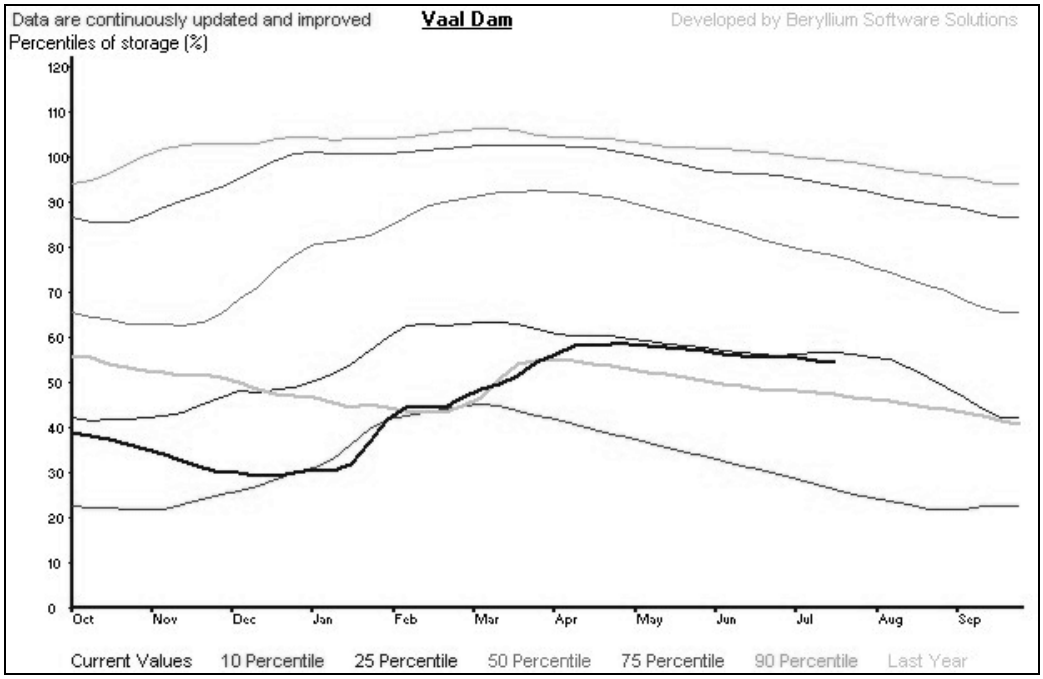

Figure 2: Example: Weekly state of dam (Example: Vaal Dam)

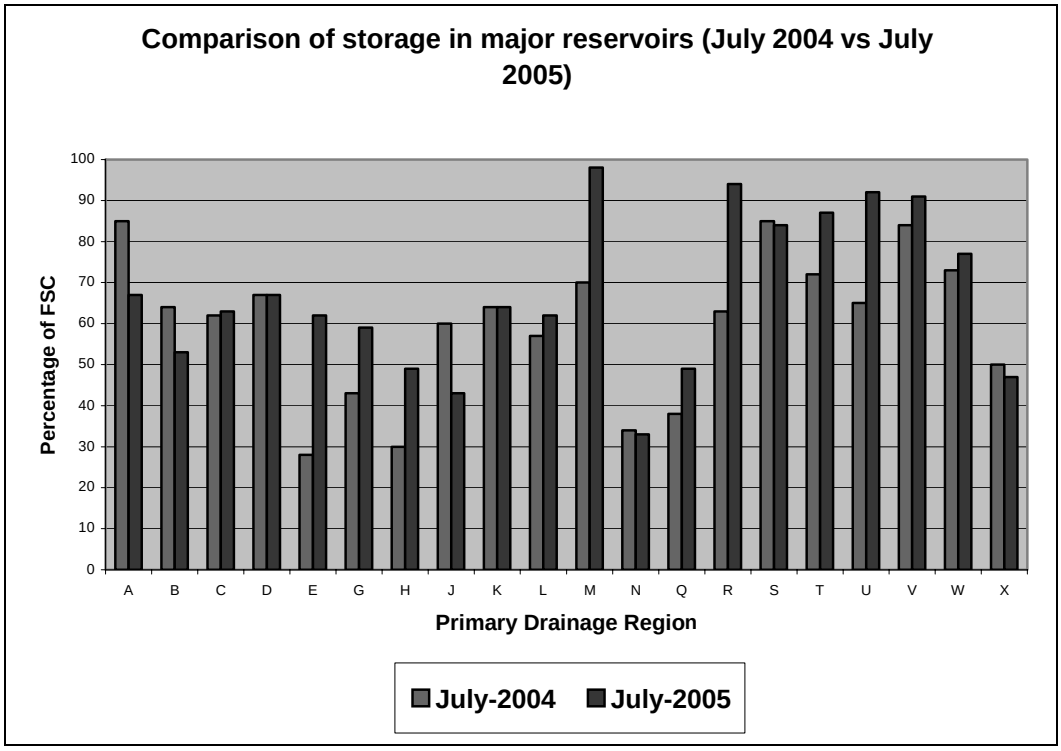

Figure 3: Example: Percentage water storage in major reservoirs per primary drainage region

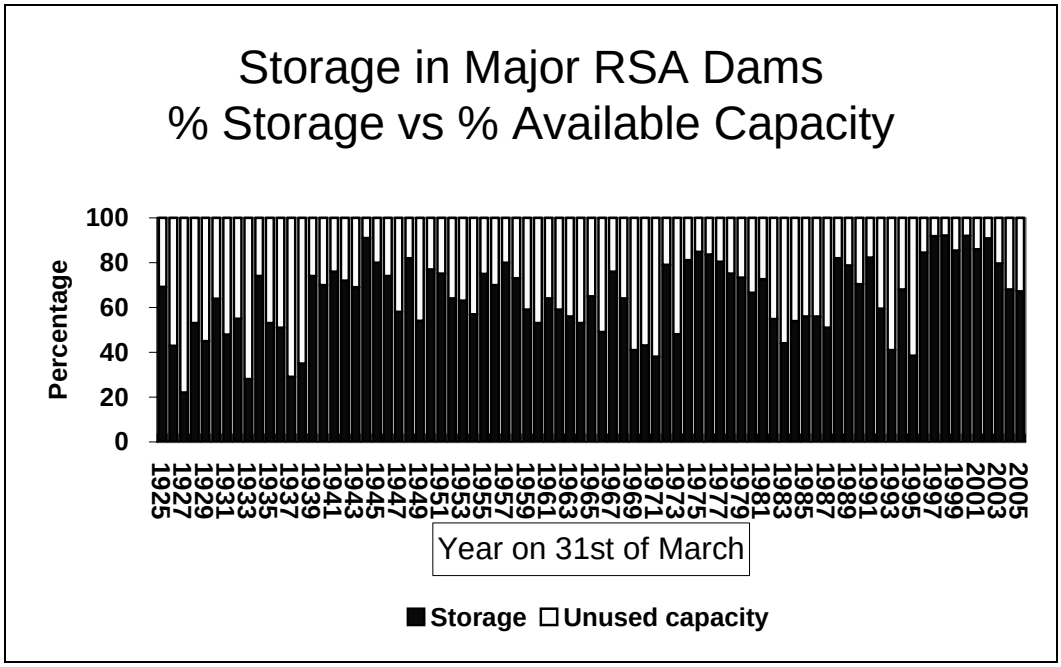

Figure 4: Example: Percentage storage in major dams (% storage vs 100% available capacity)

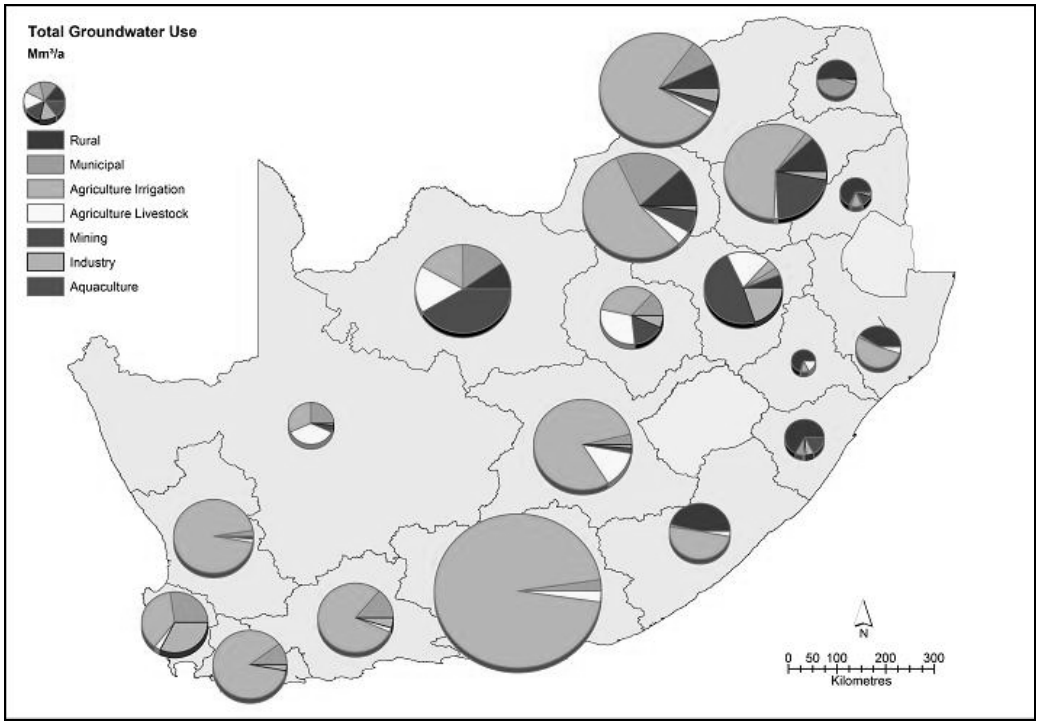

Figure 5: Example: Sectoral groundwater use per WMA

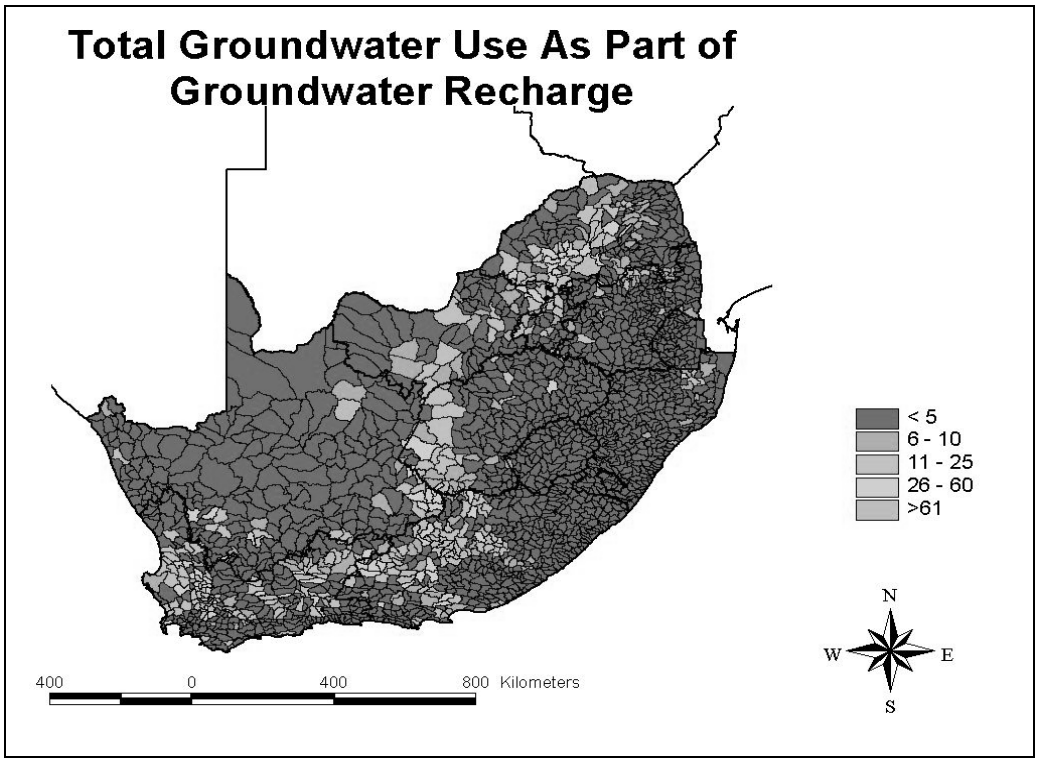

Figure 6: Example: Groundwater abstraction as the percentage of recharge

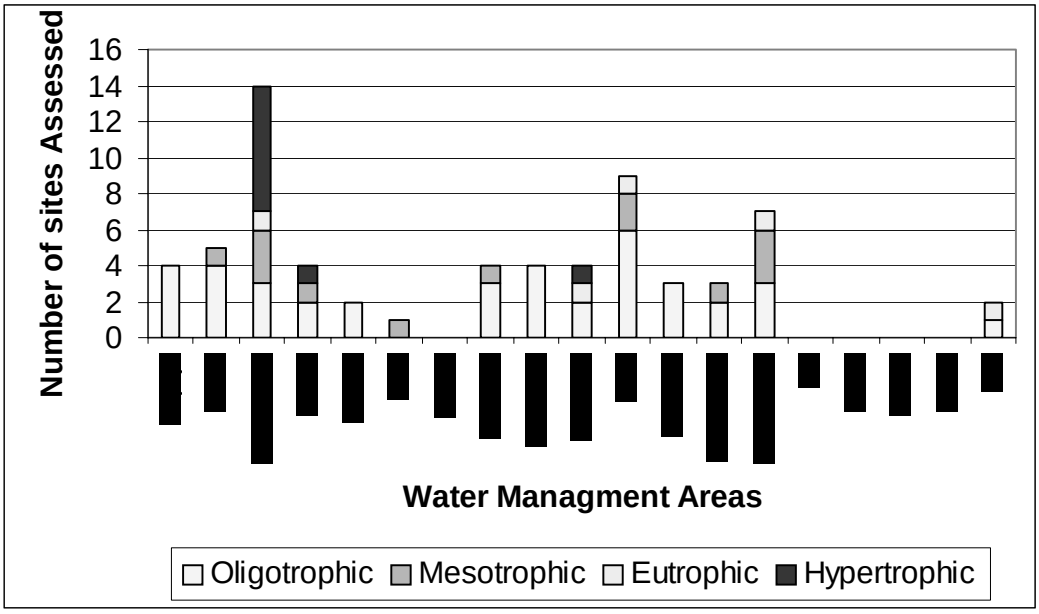

Figure 7: Example: Preliminary trophic status classification of impoundments/sampling sites in the nineteen WMA's of South Africa

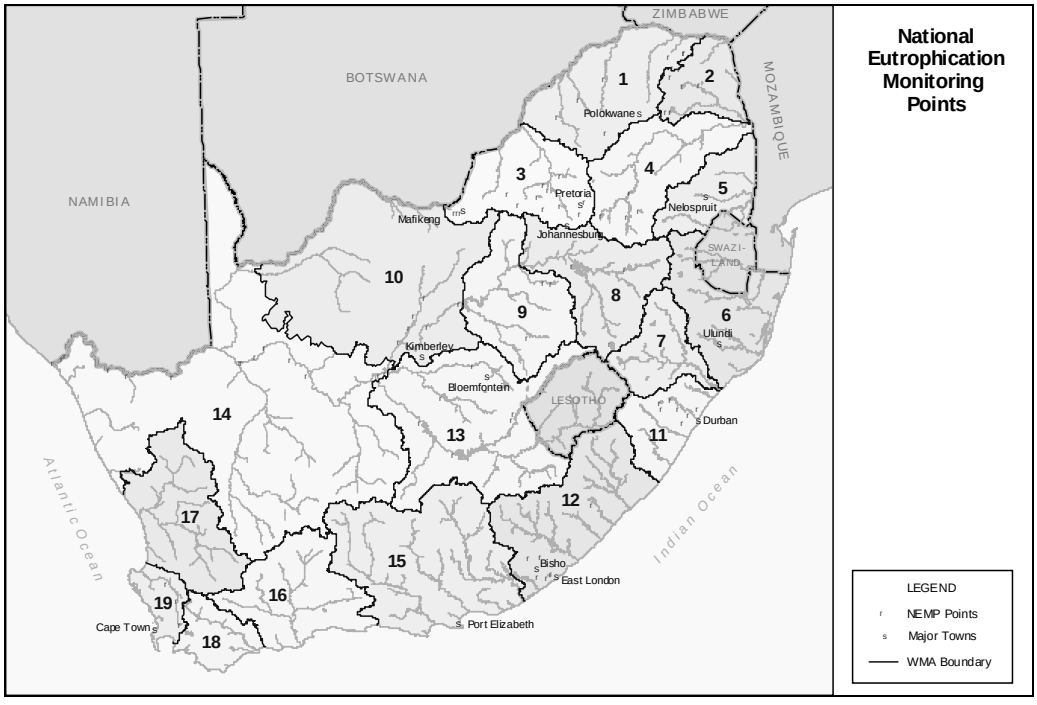

Figure 8: Example: National Eutrophication Monitoring Programme (NEMP)

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